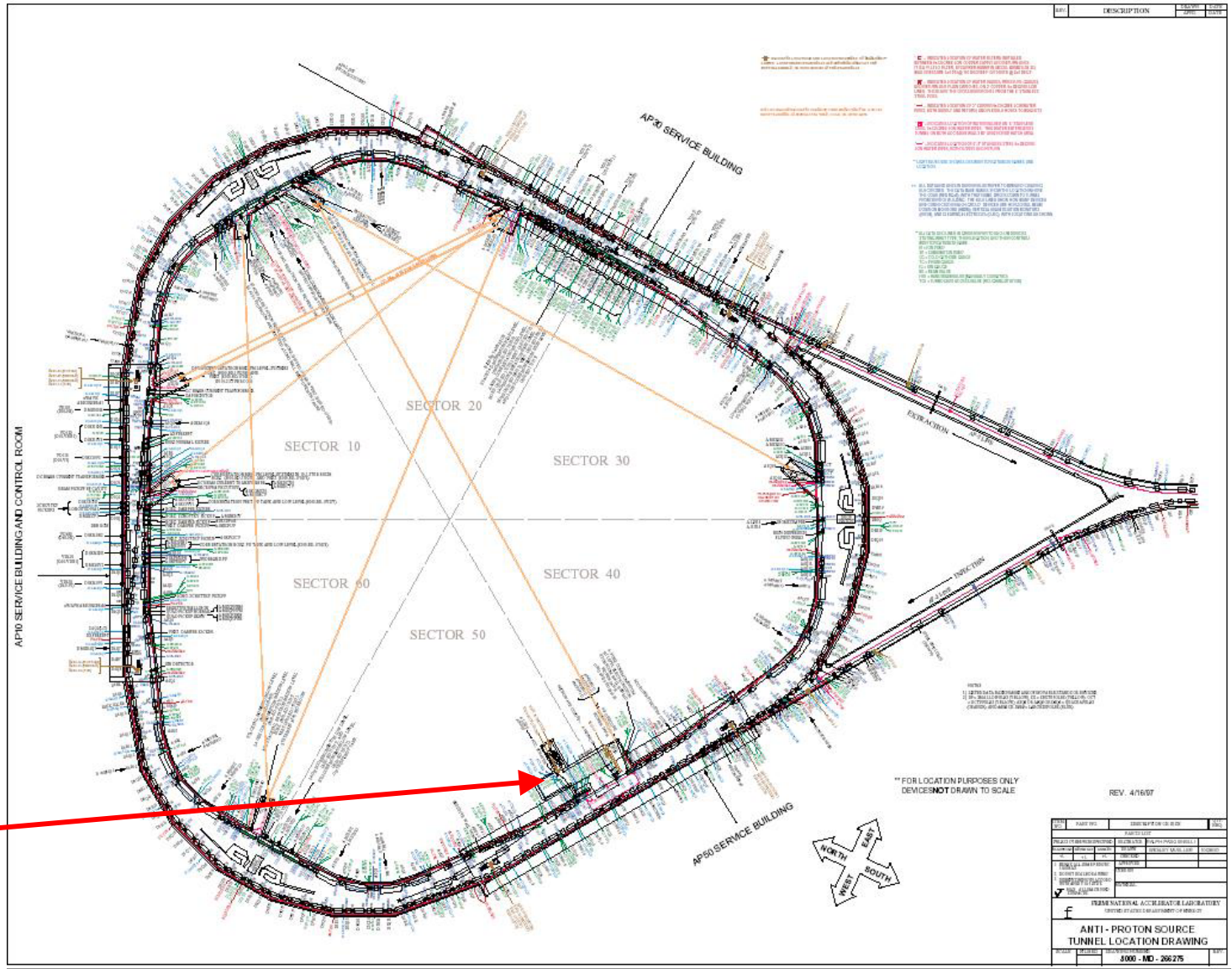
Electron Cooling in the Accumulator

Dave McGinnis

Install Electron Cooling in the Accumulator AP50 Pit

- A50 Straight Section was used for the E835 detector
  - Straight section no longer used for anything
    - Large pit beneath beam pipe (~4ft below floor level)
  - Counting room no longer used
  - AP50 Drop hatch available
- 15 meters of straight section between Q1's
  - Zero dispersion
  - Lattice functions could be modified with Q1,Q2,Q3 settings

Install Electron Cooling in the Accumulator AP50 Pit



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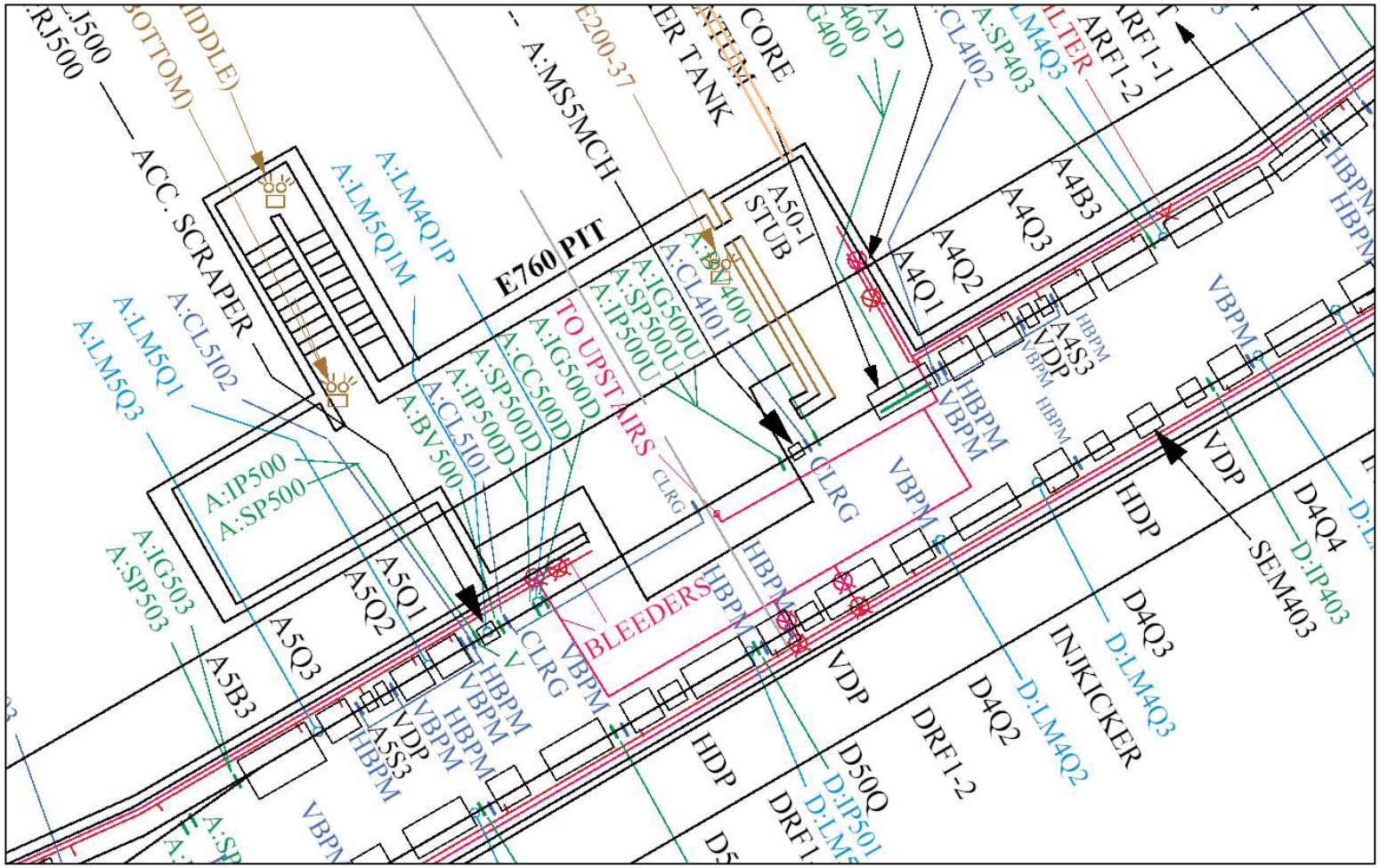
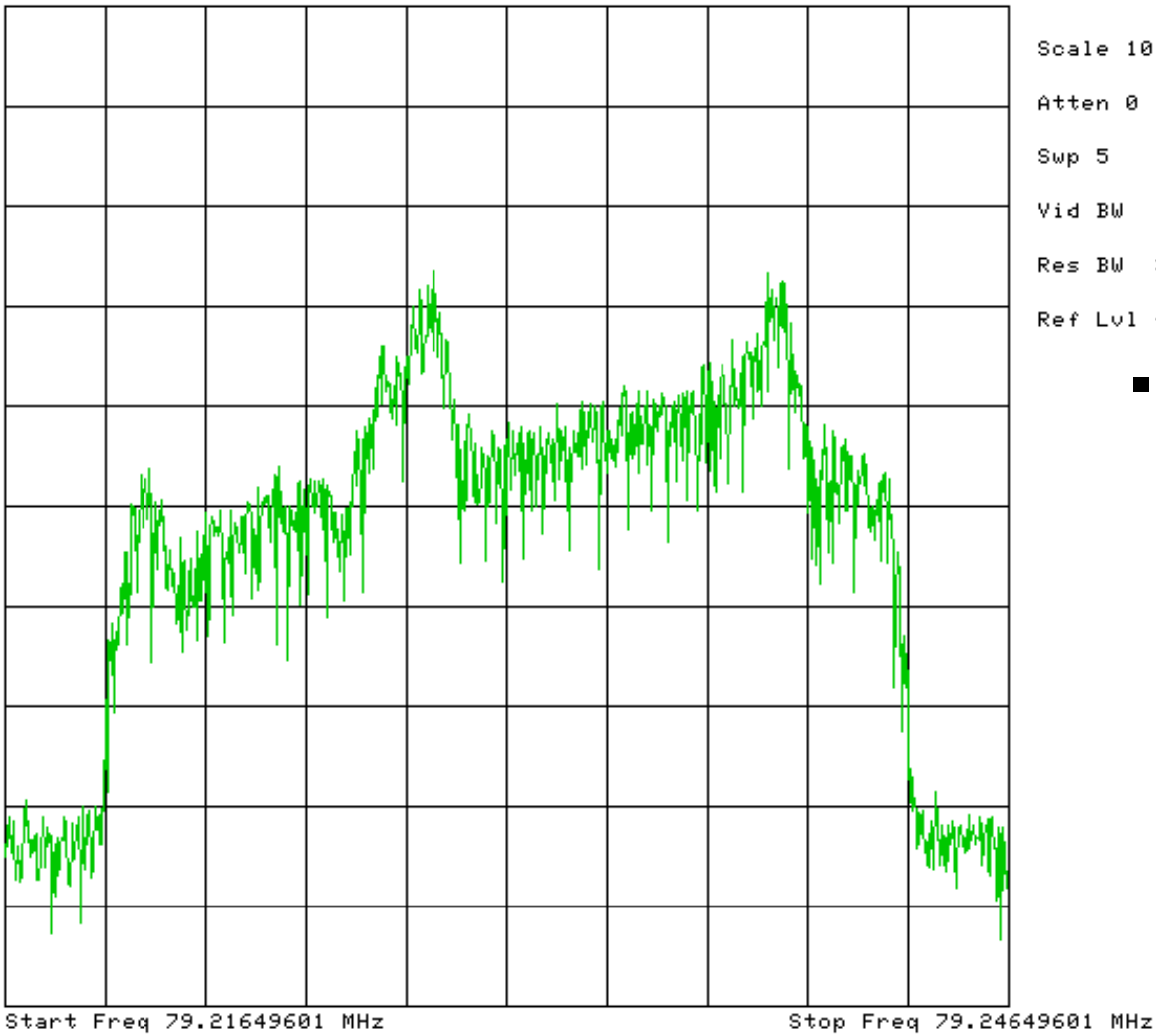
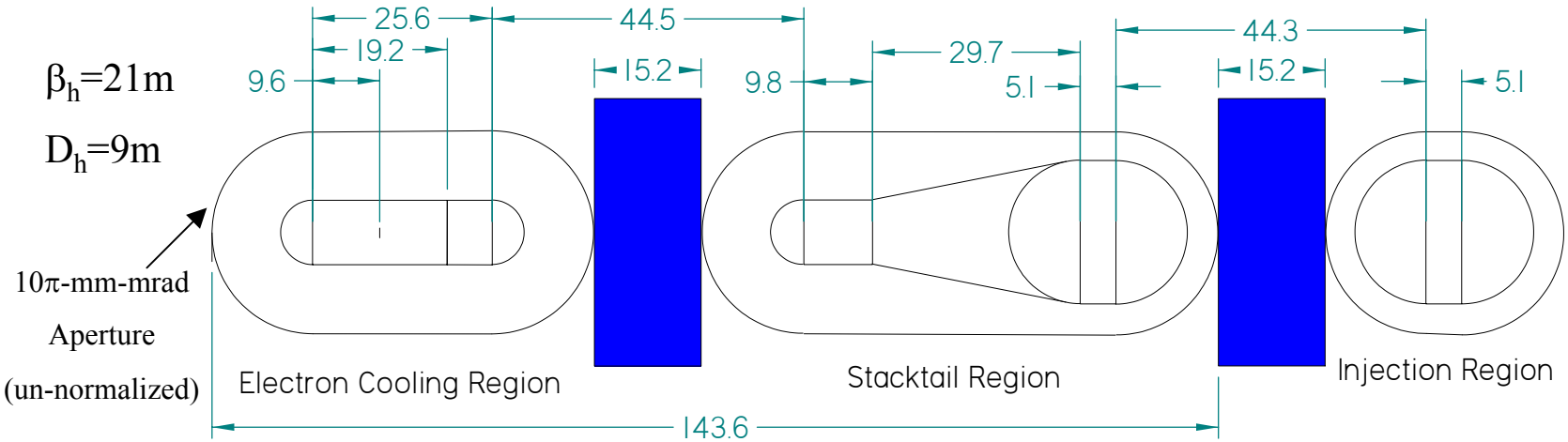


Accumulator Momentum Aperture



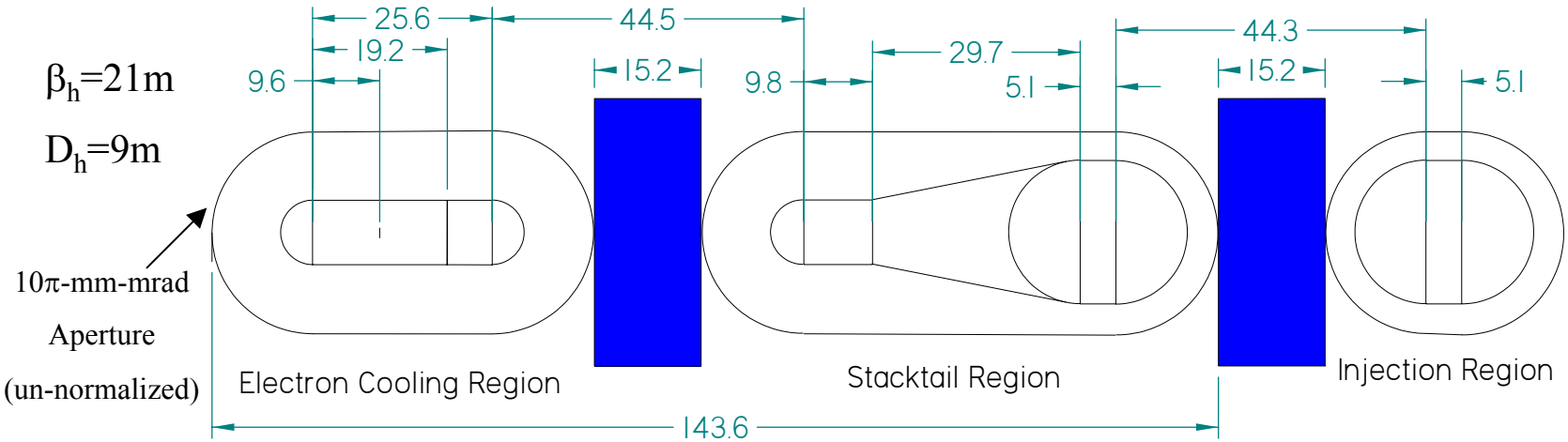
- Accumulator Momentum Aperture measured to be 206 mm at A314 scraper (J. Morgan – 5/19/03)

Accumulator Aperture with Electron Cooling



- Accumulator Aperture would be Divided into 3 Regions
  - 208 mm required for 10π-mm-mrad Aperture
- Injection Region
  - Beam is injected from the Debuncher every 1.5 seconds
  - The transverse beam size is 5π-mm-mrad
  - The momentum spread is 5 MeV
  - The Stacktail Region is shielded from the injection kickers by shutters

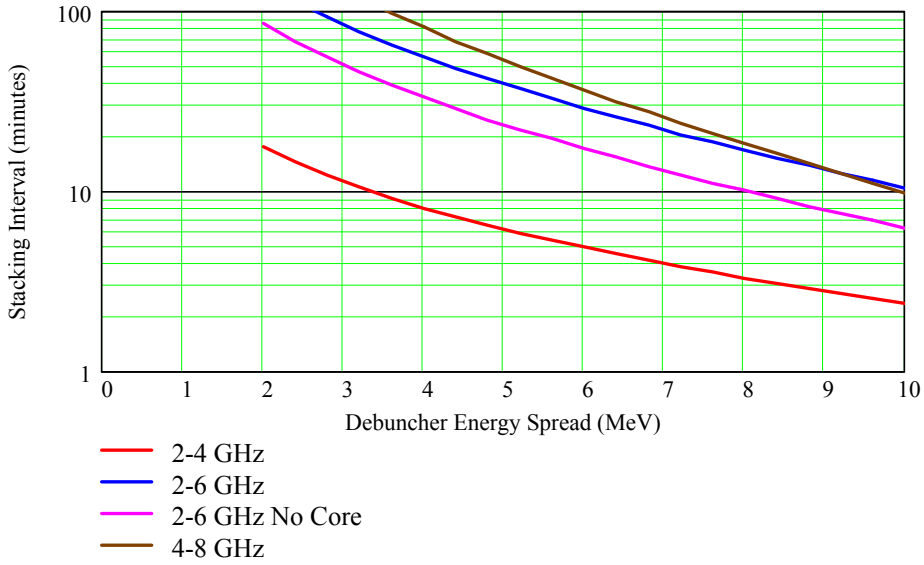
Accumulator Aperture with Electron Cooling

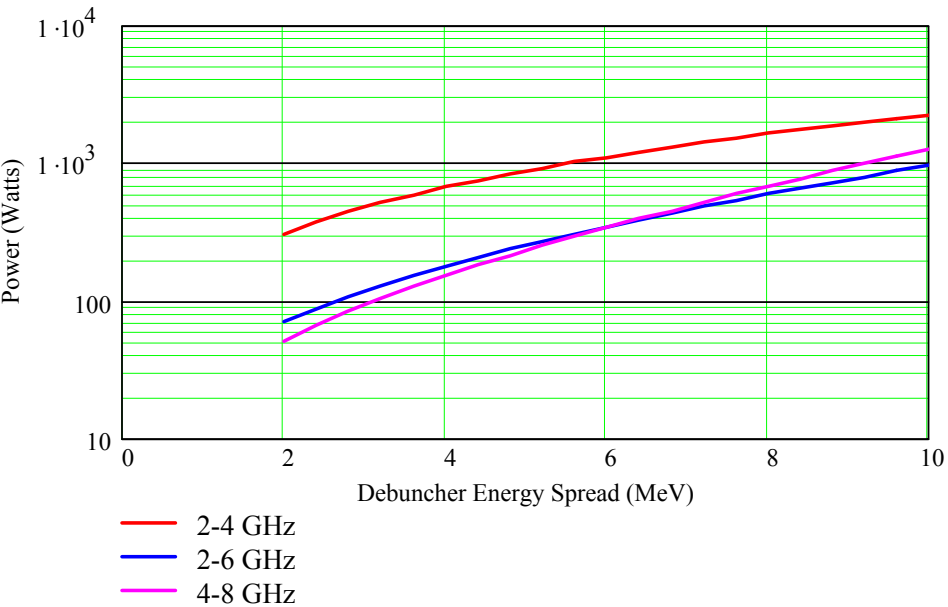


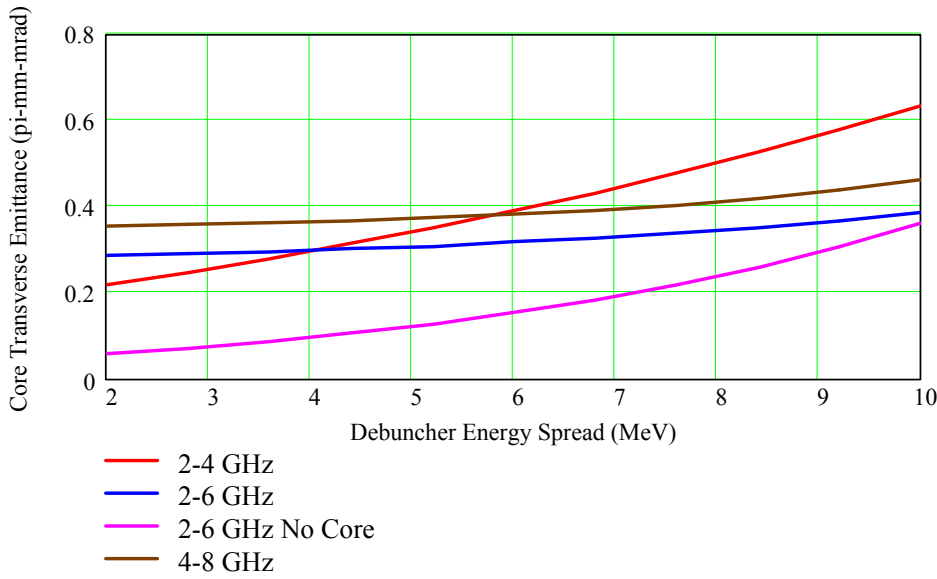
- Stacktail Region
  - The beam is bunched with RF and decelerated from the injection orbit to the Stacktail deposition orbit
  - The beam is stochastically stacked with a 4-8 GHz stacktail system and a 4-8 GHz Core system
  - The Stacktail is shielded from the high density core in the electron cooling region by means of a shutter in the stochastic cooling pickup region.
  - The beam is transversely cooled from 5 to 1 π-mm-mrad with a stacktail betatron cooling
  - The momentum aperture of the entire stacktail region is 43.5 MeV
  - The stacktail system fills 10 eV-sec (6 MeV) every 55 minutes

Stacktail Performance with an Input Flux of 90×10^{10} pbars/hr

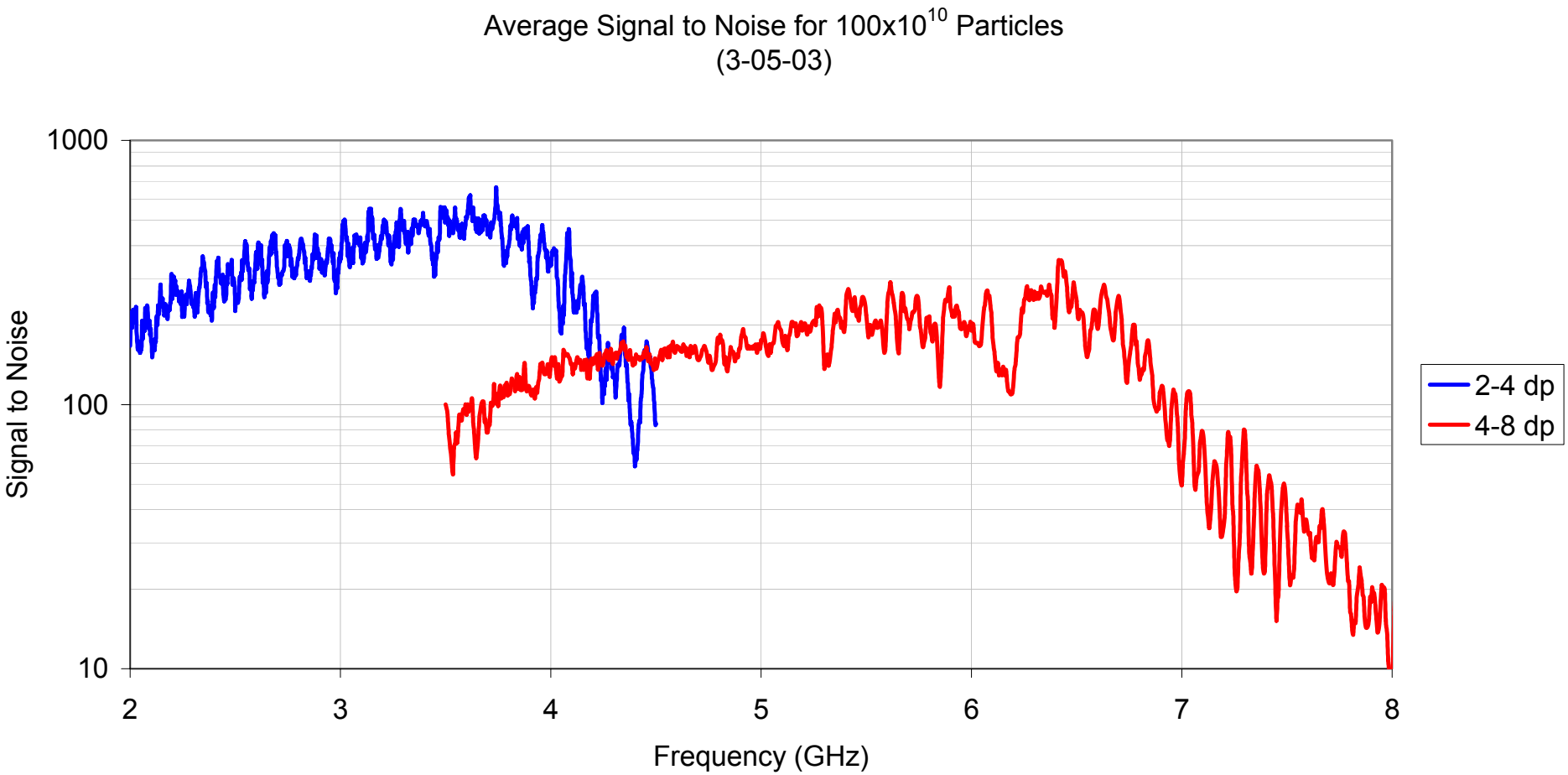
Stacktail Bandwidth	Core Bandwidth	E_{ds}	E_{dc}	$\Delta E_s + \Delta E_{bd}$	ΔE_c	Fraction Unstacked
(GHz)	(GHz)	(MeV)	(MeV)	(MeV)	(MeV)	(%)
2-4	4-8	20	5	77.4	9.6	50
2-6	4-8	8	5	48.4	9.6	66
2-6	2-6	8	8	45.2	12.8	55
4-8	4-8	5	5	33.9	9.6	72



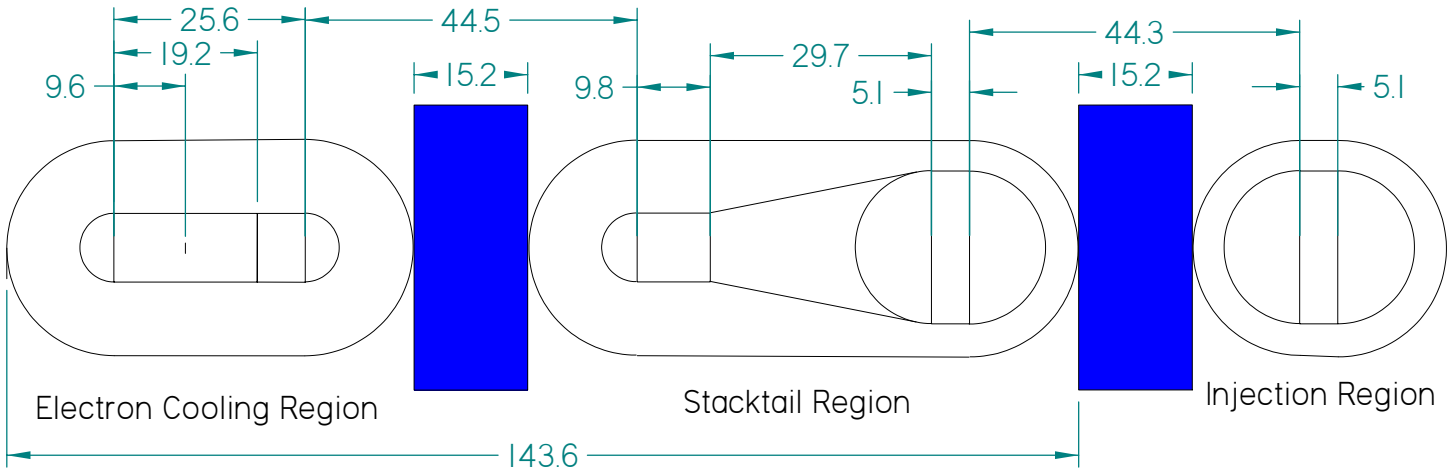




4-8 GHz High Dispersion Pickups



Accumulator Aperture with Electron Cooling



- Electron Cooling Region
  - Once 10 eV-sec of the core is filled up:
    - The Stacktail is gated off
    - The shutter to electron cooling is opened
    - The stochastic core is bunched and decelerated to the deposition orbit of the electron cooling region
    - The electron cooling shutter is closed and stochastic stacking is restarted.
    - Electron Cooling Rate – 11 eV-Sec/hr (6.8 MeV/hr)

Advantages

- Machine circumference
  - 7x smaller than Recycler
- No Rapid transfers
  - No beam loss
  - No transverse emittance dilution
  - No longitudinal emittance dilution
  - No waiting for transfer
- Electron cooler can be placed closer to ring
  - 8 GeV beam only in Accumulator
  - Shielding requirements much less
- Accelerator Performance
  - Vacuum
    - Ring Size
    - Equipment
      - Pumping speed
      - Bakeout system
  - Aperture
  - No Main Injector ramps to contend with

Disadvantages

- Stacktail Betatron cooling
- Cooling section length
  - Recycler -> 20 meters
  - Accumulator - > 12 meters
- Available longitudinal phase space

Things to Do

- Come up with a physics design for 4-8 GHz Betatron Cooling – Derwent
- Verify 4-8 GHz stacktail envelope calculations with detailed Fokker-Plank Simulations – Derwent
- Determine how to modify beta functions in A50 Sector – Werkema
- Electron Cooling Calculations – Burov
- Come up with a design of 4-8 GHz Pickups – Sun,McGinnis
- Civil Construction Aspects – Harms
- Schedule – McGinnis, Nagaitsev